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Industrial progress has not been without its cost in demands on the human being, in both the factory and the office. In the factory, however, the ingenuity of our engineers has resulted in the alleviation of some of the load on the worker through the design of industrial machines and methods to meet the pressures of our expanding manufacturing empire. A relatively high level of factory automation has been realized. On the other hand, the ever-increasing work load in the office has been met, principally, by adding to the clerical force. Office automation has not paralleled factory automation.

It is only recently that an apparent key to the office methods puzzle has been given to us by the electronics engineers. Because these engineers designed their original machines as an aid for scientists and mathematicians, there has been an interval of delayed acceptance of this new tool by the business community. During this interval there has been a successful conversion of the basic computer system. These machines have now been developed for business data processing and presently challenge our ingenuity with a promise of potential applications which stagger, but intrigue, the imagination of every systems and procedure technician.

This is an opportune time to direct our attention to the possibilities and the limitations of electronic business machines. We now know of the machines which are available or are shortly to become available. We know something, also, of the commercial installations of machines during the past year. Further, we know of some of the applications being planned by many of the prospective users of this type of equipment. With these data we may attempt an evaluation.

MACHINES

In a review of electronic equipment of latest design, we shall find that the manufacturers have gone far towards solving the problems of input and output which have previously been considered a limiting factor for business applications. It was formerly true that the central com-

puter circuits could process data at speeds far in excess of the ability of the machine to read in new data or print out fully-processed data. Because of the cost factors involved, it was felt that there should be a matching of internal speed with faster input and output devices.

Presently, all large-scale electronic systems provide for fastest input by means of magnetic tape. As tape input allows the computer to accept serially-recorded data at the rate of 15,000 decimal digits each second and parallel-recorded data at 56,000 decimal digits a second, it might be said that the input speed is fairly well balanced with internal processing speed. Manufacturers have provided card-to-tape converters as magnetic-tape-recording devices operating at 1200 digits a second. At the present time, the retention of punched cards in an electronic system seems advisable for most users. In transcribing data from source documents the cards provide a means of mechanical verification before introduction into the electronic system; they permit the use of low-cost auxiliary equipment for preparation of the data for the computer; and they provide a link with other departments or branches using punched-card equipment. For systems using common-language paper tape there is a paper-tape transcriber which writes 200 characters a second on magnetic tape. These rapid input systems are not the exclusive means of entering data into the central processor, but are mentioned to focus attention on the engineers' answer to the demand for faster data-entry devices.

There is currently a strong feeling among machine manufacturers that the time and cost of translating source documents into machine language will lead to systems designed to originate a tape recording at the time of the origin of the source document. This method also provides for the production of a tape recording at the point of occurrence of a transaction and the elimination of some familiar types of source documents. Many auxiliary machines designed for this system are now offered for sale by the equipment companies. Still in the formula and laboratory stage are document readers which will automatically translate written data into machine language.

Output of the fastest machines is also on magnetic tape. Where printed copy is desired, there is a wide choice of machines available. The most impressive of these are the newly developed high-speed printers. These print an entire line at one time, similar to conventional accounting machines, but do so at speeds up to 600 lines a minute, as contrasted to 150 lines a minute for the fastest punched-card tabulator.

One other printer, using a matrix form of print mechanism, is quoted as achieving a speed of 900 lines a minute. A recently announced electronic printer is capable of printing over 2,000 lines a minute without limitation as to width of line. Engineers have certainly answered the challenge of speed limits.

COST

Since the installation of an electronic system can only merit serious consideration if it is a cost-reduction device, no basis for judgment exists until a reasonably accurate compilation has been made of the present cost to do the work. Whereas a large company may find sufficient load in one department to occupy a processor full time, the cost recovery problem is more serious for the smaller company. These companies, whose financial operations alone could not justify a large processor, may find that a combination of applications would make the machine quite desirable. These other applications may be such operations as production scheduling or material and inventory control. Perhaps there will be a desire to enter the electronic record-keeping field on a smaller scale in order to study its potential at a minimum cost.

In all instances where a compilation of present cost has been made by a prospective user of a large electronic system, the estimated savings have sounded almost unrealistic. It is of interest to note that for two very dissimilar applications for two different companies, the estimates of each were for savings aggregating close to a half million dollars a year. Since rentals for the electronic system and equivalent punched-card equipment are comparable, the savings result principally from elimination of clerical services. One of the large-scale machines will likely do the work formerly done by a large number of employees. While it might be reasonable to assume that small-scale applications will also result in material savings, they will probably not be proportionate inasmuch as the smaller systems usually require much more manual processing. Windfall savings are bound to be realized on special applications to the machines once they are installed. In one recent application of a special job to a computer, the project cost was $15,000; if carried out by human labor, it would have been $200,000 - about 13 times as much.

There are now four companies offering for use large-scale data-processing machines designed for general business applications. Two of these companies and at least six other companies offer smaller elec-

tronic systems for lower-demand business use. Producers of large-scale equipment are Remington Rand, Inc., International Business Machines Corporation, Radio Corporation of America, and Datamatic Corporation, with their Univac, 705, Bizmac, and Raycom, respectively. These are the electronic giants which have monopolized, somewhat, the limelight of publicity up to the present time.

Nevertheless, it might well be that the smaller machines will become the work horses of modern business. These machines are produced by companies which have had long experience in the office machine business. Marchant and their Miniac, Underwood and their Elecom 125, National Cash Register and their NCR 303, ElectroData and their Datatron, Monroe and their Monrobot, Burroughs and their E101, are some who have announced the operating characteristics and costs of their electronic data-processing systems. IBM also has a Type 650 machine in this class and Remington Rand has their new Univac File Computer in the smaller machines classification.

Large-scale computers are priced at from $15,000 to $30,000 a month in rental. Most of the smaller machines range from $3,000 to $8,000 a month. While these rentals may appear to limit the use of these machines to large business enterprises, it must be pointed out that there are many relatively small businesses making use of mechanical equipment costing more than the minimum figures. Additionally, there are many large installations of punched-card machines involving equipment costing considerably more than the maximum figures for electronic systems.

SPECIAL-PURPOSE MACHINES

Attention has been focused on the general-purpose electronic business machine because of its versatility and ability to meet situations formerly treated as exceptions in systems using conventional office machines. Behind this glamorous electronic jack-of-all-trades stand other electronic machines which also deserve our attention and study. These are the special-purpose machines. Presently, it is difficult to prophesy as to which group of electronic machines, general- or special-purpose, will be the proper machine when the present period of evolution has passed. The gas and electric public utility industry is sponsoring a research project at Harvard University to investigate the potentials of special-purpose equipment for applications in the utility

field. Basically, the problem is one of cost. Engineers can design a simpler machine where the job limitations are specified.

There are some outstanding examples of this type of equipment performing small miracles in our business world. Air traffic control is handled on one of these special-purpose electronic computer systems. This high-speed system receives by teletype such flight facts as departure time, destination, route, fuel load, pay load, and other pertinent data. In less than half a second, the system electronically compares the facts on each flight with as many as 2,000 flight plans it has stored internally. It revises, cancels, or brings the information up-to-date and teletypes the required results back to the sending station - all without human handling. A large wholesale mail-order firm is using a special-purpose machine to produce up-to-the-minute inventory analyses by item under conditions of seasonal and shifting demand. Ten order clerks working at 10-key input systems to a magnetic drum memory can provide accurate tallies of orders for 21,000 different items, make available complete tallies each day, and accommodate approximately 80,000 order lines a day. Another special-purpose machine controls airline ticket reservations. Reservations or ticket orders for any one of 10,000 flights are handled within a quarter of a second after the request is keyed on the local office machine. An entire electronic system has been designed for application to department store accounting. A central processor accepts paper tapes perforated at the points of sale by cash register attachments. The processor has been designed especially for the more efficient sorting and merging of data - which are the most common clerical functions performed on accounting information. Departmental cash balances, accounts receivable, stock control, and statistical analyses are all obtained at electronic speeds from the processor. These are some of the jobs being assigned to special-purpose machines.

As price competition becomes more of a factor among electronic equipment manufacturers, we will probably see more units built with pluggable components so that unnecessary hardware will be eliminated and only those building blocks included which are needed for the specific installation. With such flexibility, there would be more of a feeling among potential users that they were not purchasing capacity for performing exceptional tasks never to be contemplated within the scope of their applications.

APPLICATIONS

The possibilities of money saving and the potentials for obtaining valuable information not heretofore considered practicable might be implied by examining some of the applications on the large-scale general-purpose machines.

It is of interest to observe that one of the first large-scale business applications (at General Electric) was in such a familiar area as payrolls. By choosing this application, which had already been successfully solved by predecessor business machines, it put the electronic system to rather a severe test for a beginner in the commerical machine field. It had to outperform equipment which had been highly developed over a long period of years and in doing so had to show an overall saving. That it has been able to do the work satisfactorily is now well known. As to the estimated savings, it is still too early to obtain conclusive comparisons.

A payroll the magnitude of this particular one, 12,000 employees, requires about twenty hours each week of the central processor time. Of even greater interest than the payroll, are the applications contemplated for the remainder of the available time. These include:

a. Material scheduling and inventory control which will result in details of material requirements by days and weeks for any production period.

b. Processing of orders through the shipping order and invoicing stage which will have as by-products sales and cost of sales journal entries and sales analysis statistics.

c. Budgeting and forecasting on a monthly, quarterly, and annual basis which will possess extreme flexibility for introduction of estimated variances and suggested policy changes.

d. Analyzing of assembly line work-load balances and automatically preparing factory machine-loading schedules which will promote new, high-efficiency operating levels.

The coupling of all of these applications into an integrated system is not an easy task, but when completed, it should furnish management with dynamic results which could have an immeasurable effect in producing more profitable operations.

In the field of life insurance, the electronic system has shown itself to be very much at home. This has been especially true of the installation at Metropolitan Life Insurance Company in New York. Here, the machine is in an ideal application utilizing its special abilities for

processing large volumes of data. At the present time these applications may be considered to be somewhat in the mathematical area; however, valuable knowledge is being acquired in electronic machine techniques. The complete accuracy of this type of equipment has been a significant factor in its success in these actuarial applications. When the installation has been completed at Pacific Mutual Life Insurance or at Franklin Life Insurance Company, we shall learn how a medium-sized company can extend the application into all of the phases of life insurance work–policy payments, renewals, accounting, and actuarial.

It has been said by many of the prophets in the electronic field that the true potential of these machines will be realized when they are set to do jobs which have previously been considered impracticable or impossible on small-scale office machines. Production planning and associated inventory control have been mentioned as offering a fertile field of exploration for optimum electronic machine usage. Such a system has been installed by one user of a large-scale processor and similar systems are contemplated by at least four companies which have ordered large-scale machines.

Since this application offers such a potential for maximum use of this powerful equipment, a summary of the features involved might provide some idea of the possibilities for bringing the many factors relating to inventory control into a central processor and the extent of the resulting benefits.

The inventory and stock control system has as its focal point the establishment on a single record of all needed data pertaining to each part. During the processing of daily requirements against this record, the protective base stock point is automatically adjusted for engineering changes. It is then tested for days of coverage and, where an order point has been reached, an order is automatically placed. This order is in the form of a production authorization card and contains all significant item data, the economical order size, the manufacturing starting date, and date the item must enter the stock. If, because of unusual circumstances, the stock should drop below the protective level, the need to expedite existing orders will be automatically indicated. Expediting cards will show the exhaustion date of the stock on hand.

One of the novel features of this system which has made it so useful is the method of determining average daily requirements for each part. A master tape is maintained on which is indicated every feature number or assembly number where each of the parts is used and the

number of times the part is used on that bill of materials. This record is continuously up-dated for all engineering changes. A sales analysis showing feature or assembly requirements and anticipated daily production figures by months for the next twelve months is processed together with the where-used tape. This yields a spread of daily requirements for all parts for a twelve-month period.

This system is an attempt to make completely automatic the record-processing necessary to inventory control. It should result in reduced inventories, better parts supplies, more accurate records, and large dollar savings in many areas of the production planning department.

LIMITATIONS

Any evaluation of a proposal for changed methods or new mechanical or electronic equipment must assemble for consideration the known limitations inherent in the proposal. We are presently at a distinct disadvantage inasmuch as the field of past experience in business applications of electronics has been restricted to such a brief period. However, there has been sufficient exposure to the problem in its pioneering stages to pinpoint some areas of limitation. A few of these limitations are factors which might deter entry into this electronic method; others are factors to be considered after the decision has been made to acquire such a system.

Those factors which should be considered first are the limitations imposed by the magnitude of the equipment. These are cost, reassignment of personnel, and extent of required system changes.

A substantial cost will probably be incurred before the lights go on in your data processor. Weeks of decision are usually followed by months of system analysis and programming. Since this may require the equivalent of 30 to 50 man-years for the large electronic processor, the cost of this phase of the preparatory work may be from $150,000 to over $300,000. For equipment as important as this, a suitable site must be prepared. Usually to capitalize on its advertising value, the site may look something like a show window with plate glass to accommodate all observers. The equipment functions within certain temperature and humidity ranges and hence requires an air conditioning or other cooling system. The electronic machine utilizes rather extensive floor space and the maintenance and repair equipment must also be adequately housed. Site preparation may cost approximately $150,000. While

these costs, which are typical only for the largest equipment, are not repetitive, their amortization must be covered by savings during the period of use. Machine cost has already been mentioned and may be in the form of rentals or purchase price depending on the contract with the particular manufacturer. If an installation is borderline as to allowable costs, a loss of enthusiasm for electronics may occur shortly after a consideration of these cost limitations.

Where this equipment results in the displacement of many persons, as in the large installations, there is a twofold problem. One is to establish, if possible, a policy that no personnel will be dismissed and the other is to disseminate this policy early enough to allay fears and avoid adverse effects on employee morale. Consolidated Edison, Metropolitan Life, Pacific Mutual Life, to mention a few, have made a study of turnover, attrition, and retirement rates and have ascertained that transfers, retraining and a lower new-hiring rate will completely solve this problem. It is difficult to conceive of instances where businesses large enough for major electronic systems would not be able to adjust to the limitation resulting from the necessity for personnel reassignment.

The limitation imposed by the extent of required system changes has many facets. Probably the most important is inertia. Never before has there been the requirement for such a complete change of methods in such a wide area as is implicit in the electronic approach to data processing. This is a job for imaginative thinkers having the earnest support of top management. Departmental barriers may disappear and supervisors of long service may find their departments eliminated entirely. There will be many masses of resistance, some of them of a political nature, which must be ignored for the common good of the organization.

Another facet of this same limitation is the need for the abilities of trained systems personnel. Since the installation of an electronic system must be preceded with a thorough review of the existing method of accomplishing the proposed application, a well-trained systems group must devote full time to this project. Where the organization already has a permanent methods and procedures group, this limitation may not be a serious one. Where it does not have a systems staff, the lack of experienced personnel will present a roadblock to development until a selection and training program has been completed.

Still another facet of the limitation involved in an extensive sys-

tems change pertains to the interrelation of all departments of a business. Any change within the organization sets forth a chain reaction which is often complex enough to require many weeks of study by the methods analyst. These interrelations usually limit the extent of system integration.

There must be a review of the old problem of the relative advantages of centralization as opposed to decentralization of the record-keeping function. This has posed a major problem to those users of electronic machines where the trend in recent years has been towards decentralization. Now we have a machine of such great capacity that it creates a need for bringing into a central point all data processing. Where there has been a costly program of establishing branch record keeping, this may limit to a large measure the amount of work which may be economically assigned to the electronic system.

The point-of-transaction recorders mentioned previously may be the answer to the problem of assembling data on a branch basis by permitting the production of a paper tape as a by-product of branch record-keeping functions. This tape could be transmitted to the central office by wire or mail for rapid conversion into the machine language. Where there has been decentralization of accounting functions because of the magnitude of the entire processing problem, there may be a real possibility that each of the decentralized branches might have its own electronic system. All branch systems would then be very closely integrated with the home office system. Although this plan is not yet in effect, there are presently at least three companies that have ordered electronic systems for use at multiple locations.

The capabilities of electronic machines which permit all data processing to be accomplished within the confines of one department lead to a consideration of the hazards of such a procedure. Where reliance is placed on one piece of equipment for the performance of all of the principal recording function, safeguards must be provided to insure continuous operation of the record-keeping system. For some time into the future, the electronic data processors will be rather widely distributed throughout the country so that availability of alternate emergency facilities may be limited to a few areas. This places a heavy responsibility on the machine manufacturers to provide highly skilled maintenance personnel and complete, readily accessible stocks of repair parts. The tolerance for unscheduled machine down time will be quite limited.

Reliance must also be placed on relatively few operating personnel for each machine unit. In addition to the problems of internal control created by this situation, there are problems of establishing working teams and training programs for team replacements. Initially, the operating team will lack experience in the use and application of the equipment. It may well be many years before electronic system experts emerge from the vast group of machine trainees.

Some limitations of the electronic system itself have already become apparent. This system is not adaptable to one-time jobs or special reports. The amount of work necessary to analyze a one-time report and program it for the electronic system is usually so excessive as compared with the results that it is not an economical procedure. Recently a bill frequency analysis was programmed by a public utility group for an applications test. It took 1,400 man-hours to program the job and ten minutes to run through the machine. As a general rule, the electronic system is adaptable only in those situations where the preparatory time will be absorbed in repetitive applications, or where the cost of preparing the report in this manner is less than by any other available method.

The use of magnetic tape as a record offers some challenge to methods designers in order to overcome its limitations. Magnetic tape presently offers maximum speed and flexibility within the electronic system. For this reason, it is the proper filing medium for such master data as customer accounts, employee records, or inventory balances. It is reasonable to assume that access to this master file data will be required on a continuing basis for the replies to customer or employee queries. The problem is how to provide ready access to the data on tape reels, especially when the machine is in operation on its daily tasks. No electronic solution has been offered to this problem other than the file interrogator on the Bizmac, which is limited, of course, to inactive reels in the tape files. Presently designed procedures utilize a conventional register printed out on a periodic basis at the time accumulated changes are applied to the master information. In the interim period, supplements to the periodic register are prepared from the daily changes.

There is no longer any justification for qualms with regard to the stability or reliability of the tape as a record. As you probably know, in the electronic system there is a continuous regeneration of the tape-

stored data. Tape files are up-dated, corrected, or amended by creating a new tape record from the combination of the old record and a change record. Tape is a full trace medium. It permits the retaining of superseded tapes for a sufficient period to ascertain that new tapes are correct before the old tapes are erased and reused. Recommended maximum tape usage is 1,400 passes through the read-write heads, which would occur in approximately 5-1/2 years on a daily use basis. Limiting factors on tape are temperature and humidity. Ideal tape conditions are a temperature in the range of 60° to 80° Fahrenheit and from 40% to 60% relative humidity.

Unless your thinking has been conditioned for it, it is difficult to be a pioneer. This may present a limitation that can only be solved by time. Somebody is going to devise the methods of accounting control for data which are being processed at electronic speed. It will have to be a method which will not detract from the basic advantages of the machine by requiring a slowdown to allow human read-out of data. It may consist of some simple procedure such as storing control totals within the main frame of the machine and allowing the electronic bits to proceed in their orderly fashion until an error is detected by the machine itself. Somebody is going to devise short cuts in programming so that this rather formidable task will be cut down to a size less challenging than at present. This may be accomplished by use of stock routines made available by the machine manufacturers from their libraries. Some work has already been done in this direction.

While there is every reason to believe that there will be continued development and evolution of electronic machines and ideas, it would appear that the machines are presently developed beyond our current thinking or experience with regard to making maximum use of their potentials. This, then, is the real challenge to systems and procedures personnel. The machines are more versatile than anything heretofore offered for office use. One may well ask whether many of the partially-mechanized systems will change over to electronic systems. It all depends on the ability and ingenuity of those responsible for system applications. The savings inherent in this new tool are being made known to management and there are now very few unreceptive individuals on boards of directors of the larger companies. The most insistent pressure will be on the systems people who will have to meet this challenge head on and solve the application problem as quickly as possible.

There are now very few valid reasons for systems people to shy away from consideration of the use of electronic data processors for accounting applications. If your company is not presently engaged in an electronics study program, is your reason good enough?